Technical Assistance
HYDROLOGY PROJECT

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Training module # WQ - 42

How to measure Boron by Curcumin Method

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DHV Consultants BV & DELFT HYDRAULICS

with
HALCROW, TAHAL, CES, ORG & JPS

Table of contents

1. Module context

This module deals with the significance of boron to water quality and methods for measuring boron in water samples. Modules in which prior training is required to complete this module successfully and other available, related modules in this category are listed in the table below.

While designing a training course, the relationship between this module and the others would be maintained by keeping them close together in the syllabus and placing them in a logical sequence. The actual selection of the topics and the depth of training would, of course, depend on the training needs of the participants, i.e. their knowledge level and skills performance upon the start of the course.

No.	Module title	Code	Objectives
1.	Basic water quality concepts	**WQ - 01**	• Discuss the common water quality parameters • List important water quality issues
2	Basic chemistry concepts	**WQ - 02**	• Convert units from one to another • Discuss the basic concepts of quantitative chemistry • Report analytical results with the correct number of significant digits.
3.	Major ions in water	**WQ - 28**	• Know the major ions in water and air sources • Understand the significance of major ion concentrations
4.	Absorption Spectroscopy	**WQ - 34**	• Understand the principle of absorption spectroscopy • Explain the use of absorption spectroscopy for chemical analyses

2. Module profile

Title	:	How to measure Boron by Curcumin Methos
Target group	:	HIS function(s): Q2, Q3, Q5, Q6
Duration	:	1 Theoretical session of 40 min, plus 1 Practical Laboratory session of 120 min, plus 1 Report writing session of 20 min.
Objectives	:	After the training the participants will • Understand the relevance of boron to water quality • Know how to make analysis of boron in water samples.
Key concepts	:	• Curcumin method • Relation of boron concentration to different water types
Training methods	:	Lecture, laboratory analytical exercise
Training tools required	:	Board, flipchart, OHS, Complete Laboratory Facilities for Boron Analysis
Handouts	:	As provided in this module, Including SAP for Analysis of Boron
Further reading and references	:	• Chemistry for environmental engineers - C. N. Sawyer, P. L. McCarty & G. F. Parkin, McGraw - Hill, Inc., 1994 • Standard methods for the examination of water and wastewaters, AWWA, 19th edition, 1995

3. Session plan

No	Activities	Time	Tools
1	***Preparations*** • Prepare reagents according to SAP for boron determination • Prepare samples B & C by spiking tap water with required amount of boron using standard stock solution		
2	***Introduction*** • Introduce the session • Introduce the subject of boron in water • Talk about the effect of boron on plants and the need to measure boron in irrigation waters	10 min	OHS
3	***Curcumin Method*** • Talk about the reaction of boron with curcumin • Ask participants to read SAP for boron determination • Explain the overall aim of this practical module • Explain how to complete the concentration/ absorbance table and draw the calibration curve • Describe the content of the report and how it should be written	30 min	OHS
4	***Practical Session*** • Allow participants to conduct analysis according to SAP • Stress the need to write-up results as the analysis proceeds • Be available to guide participants and answer questions	120 min	
	Report Writing: • Allow participants to complete their reprots • Give the 'correct answers' to boron determinations • Ask participants to suggest reasons for discrepancies between their results and the 'actual results;	20 min	Use flipchart

4. Overhead/flipchart master

OHS format guidelines

Type of text	Style	Setting
Headings:	OHS-Title	Arial 30-36, with bottom border line (not: underline)
Text:	OHS-lev1 OHS-lev2	Arial 24-26, maximum two levels
Case:		Sentence case. Avoid full text in UPPERCASE.
Italics:		Use occasionally and in a consistent way
Listings:	OHS-lev1 OHS-lev1-Numbered	Big bullets. Numbers for definite series of steps. Avoid roman numbers and letters.
Colours:		None, as these get lost in photocopying and some colours do not reproduce at all.
Formulas/Equations	OHS-Equation	Use of a table will ease horizontal alignment over more lines (columns) Use equation editor for advanced formatting only

Measurement of Boron(1)

- Boron occurs naturally in fresh and saline waters
- It can also result from pollution by sewage or industrial discharges
- Sea water contains approximately 5 mg/L of boron

Measurement of Boron (2)

- Boron at low concentrations is an essential plant nutrient
- At high concentrations (above approximately 0.5 – 2.0mg/L depending upon the species) it is toxic to many plants
- Irrigation waters must be relatively free of boron
- Boron can also be toxic to mammals if sufficient quantity is ingested

Curcumin Method:

1. Boron in solution forms a red product (rosacyanine) when acidified and evaporated in the presence of curcumin
2. This red compound is then measured in a spectrophotometrically at 540 nm

Aim:

1. To determine the concentration of boron ion in a number of different samples spectrophotometry

Sample	Source	Probable B Conc. mg/L
A	Tap water	0 – 0.1
B	River water which is suitable for irrigation	0.1 – 0.5
C	River water which is unsuitable for irrigation	2.0 – 3.0

Observations (1)

1. Fill in the following table as you proceed with the method:

Sample	Absorbance at 540 nm
0 mg/l Standard Solution	
0.25 mg/l Standard Solution	
0.5 mg/l Standard Solution	
0.75 mg/l Standard Solution	
1.0 mg/l Standard Solution	
A	
B	
C	

Observations (2)

2. Use the values of the standard solutions to plot a standard curve of boron versus absorbance

3. Read the boron concentration of the three samples from the standard curve

Report

- The aim of the investigation
- The boron content of the three waters
- The type of water each sample represents and the suitability of each water for irrigation purposes

5. Evaluation sheets

6. Handout

Measurement of Boron (1)

- Boron occurs naturally in fresh and saline waters
- It can also result from pollution by sewage or industrial discharges
- Sea water contains approximately 5 mg/L of boron
- Boron at low concentrations is an essential plant nutrient
- At high concentrations (above approximately 0.5 – 2.0mg/L depending upon the species) it is toxic to many plants
- Irrigation waters must be relatively free of boron
- Boron can also be toxic to mammals if sufficient quantity is ingested

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0 mg/l Standard Solution	
0.25 mg/l Standard Solution	
0.5 mg/l Standard Solution	
0.75 mg/l Standard Solution	
1.0 mg/l Standard Solution	
A	
B	
C	

2. Use the values of the standard solutions to plot a standard curve of boron versus absorbance
3. Read the boron concentration of the three samples from the standard curve

Report

- The aim of the investigation
- The boron content of the three waters
- The type of water each sample represents and the suitability of each water for irrigation purposes

Add copy of Main text in chapter 8, for all participants.

7. Additional handout

These handouts are distributed during delivery and contain test questions, answers to questions, special worksheets, optional information, and other matters you would not like to be seen in the regular handouts.

It is a good practice to pre-punch these additional handouts, so the participants can easily insert them in the main handout folder.

8. Main text

Contents

How to measure Boron by Curcumin Method

1. Introduction

Boron occurs naturally in both fresh and saline waters. In fresh water, boron can occur due to the weathering of rocks, soil leaching and other natural processes or be present due to pollution from industrial discharges and sewage effluents. Sea water contains approximately 5 mg/L of boron.

Boron at low concentrations is an essential plant nutrient but at higher concentrations (above approximately 0.5 to 2.0 mg/L depending upon the plant species) is toxic to many plants. It is necessary to ensure waters used for irrigation are relatively free of the element.

Boron can also be toxic to mammals, including humans if taken in large amounts or over a protracted period.

2. Curcumin Method

This method relies on the fact that boron in solution forms a red product (rosacyanine) when acidified and evaporated in the presence of curcumin. The red compound is then dissolved in a suitable solvent and measured in a spectrophotometer at 540 nm.

3. Experiment

Aim

a. To determine the concentration of boron in a number of different samples by Curcumin Method.

Method

a. Collect a sample from each of the buckets marked A, B and C.

b. The three samples all represent different types of water each with different concentrations of boron.

   A – Tap water
   B – River water which is suitable for irrigation
   C – River water which is unsuitable for irrigation

c. Determine the boron in each sample according to the Standard Analytical Procedure for boron.

Sample	Source	Probable boron conc., mg/L
A	Tap water	0 – 0.1
B	River water which is suitable for irrigation	0.1 – 0.5
C	River water which is unsuitable for irrigation	2.0 – 3.0

Observations & calculations

a. Fill in the following table as you proceed with the method:

Sample	Absorbance at 540 nm
0 mg/l Standard Solution	
0.25 mg/l Standard Solution	
0.5 mg/l Standard Solution	
0.75 mg/l Standard Solution	
1.0 mg/l Standard Solution	
A	
B	
C	

b. Use the values of the standard solutions in the table to plot a standard curve of boron versus absorbance.

c. Read the boron concentration of the three samples from the standard curve.

Report

When writing your report the following aspects should be addressed:

- the aim of the investigation
- the results that you have produced
- the type of water each sample represents and the suitability of each water for irrigation use